FISH FAUNA OF *POSIDONIA OCEANICA* SEAGRASS MEADOWS IN PALMA BAY (BALEARIC ISLANDS).

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RÉSUMÉ. - Le peuplement ichtyologique des herbiers de *Posidonia oceanica* a été étudié dans la baie de Palma (Iles Baléares) pendant le mois de mai de 1991. Un total de 41 espèces appartenant à 20 familles a été récolté en huit échantillons à la profondeur de 25-30 mètres grâce à un chalut à perche de petite dimension. Des différences nycthémérales quantitatives ont été observées qui sont dues à la dominance, aussi bien en nombre qu'en biomasse, de la famille Centracanthidae dans les échantillons nocturnes et des familles Labridae et Scorpaenidae dans les échantillons diurnes. Cependant, les indices globaux d'abondance de biomasse et de diversité ne permettent pas de mettre en évidence des différences. La composition spécifique du peuplement est semblable à celle de la faune ichtyologique des autres herbiers de Méditerranée à même profondeur. Les paramètres écologiques du peuplement diffèrent parfois, en liaison avec quelques facteurs environnementaux qui ont une grande influence sur ces types de peuplements.

Key-words. - Fish fauna, *Posidonia oceanica* beds, MED, Majorca, Diel variation.

The studies of the seagrass meadows conducted in different parts of the world show their great importance as fish nursery areas for commercial fish species as well as of recreational value. They are also a source of food, not only for the associated fauna, but also for species living in more distant sites (Kikuchi, 1974; Kikuchi and Peres, 1977; Odgen, 1980; Robblee and Zieman, 1984).

Although *Posidonia oceanica* meadows cover more than 2% of the total extent of the Mediterranean and support very important artisanal fisheries, the information on their ichthyofauna is limited to a few reports. The first studies were conducted by Zei (1962) in the Adriatic and by Massuti (1965) and Oliver (1966) in shallow seagrass beds in the Balearic Islands. Since then the description of the icthyofauna of this community has been conducted along the French coast, especially in Port-Cros and Scandola marine reserves (Bell and Harmelin-Vivien, 1982, 1983; Harmelin-Vivien, 1982, 1983, 1984; Seloudre and Chauvet, 1986; Francour, 1989, 1991a, 1991b).

The aim of this study is to describe the composition, abundance and diversity of the fish fauna of *P. oceanica* beds between 25 and 30 m depth in Palma Bay (Western Mediterranean) and to determine any daily changes which might occur in the composition of this community. Although this paper is not exhaustive, being limited both to a reduced area and to a depth stratum, we believe it constitutes an essential starting point for following studies.

Materials and Methods

Day and night samples were taken at 25-30 m depth, between the 16 and 21 May 1991, from *Posidonia oceanica* seagrass beds in Palma Bay (Fig. 1). The sampling area has a moderate seagrass coverage with bare sandy patches. During the study period the water temperature was 19°C at the surface and 17.3°C at the bottom. The average values of nitrates, phosphates and silicates were: 0.21, 0.23 and 0.93 mg-at/l, respectively.

The fish samples were collected with a beam trawl (1.8 m width and 0.8 m height). Eight trawlings of 15 to 30 min duration, with an average speed of 1.5-2 knots were conducted. Daytime samples were collected between 14 and 16 GMT and night samples between 22 and 24 GMT. The fish collected were sorted, and the total number of individuals and the biomass were recorded for each species per sample. The total length was also measured, to the nearest mm, for all specimens.

To detect diel patterns in fish abundance, cluster analysis was applied to species abundance. The Percentage of Similarity ($PS = 1-0.5E/p_{xi}-p_{yi}/$, where p_{xi} and p_{yi} are the occurrence probability of the species i in the samples x or y) was chosen as the similarity coefficient, because this index is not affected by sample size (Kohn and Riggs, 1982). The UPGMA (unweighted pair-group using arithmetic averages) was used as the clustering algorithm (Sneath and Sokal, 1973).

The ecological parameters: mean abundance, mean biomass, total and mean species richness, Shannon-Weaver diversity index (H' = -

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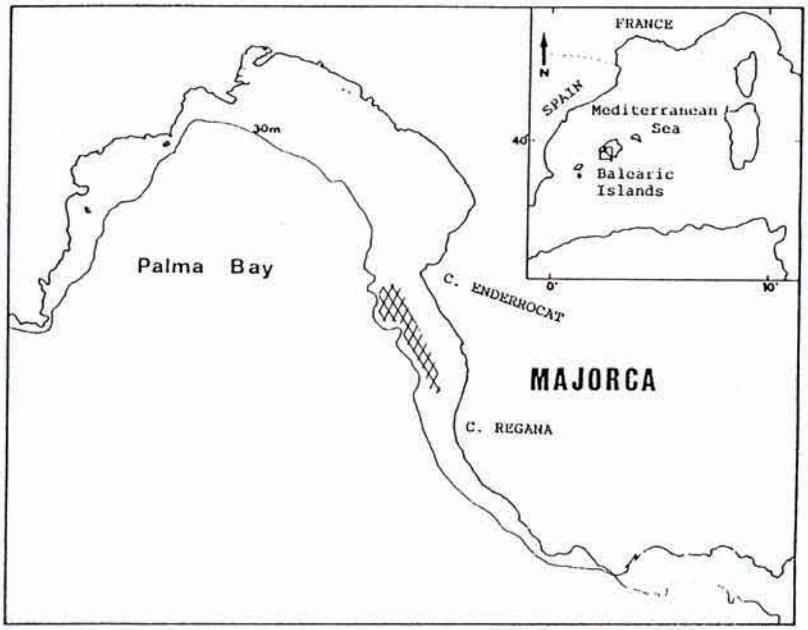

Fig. 1. - Study area and situation of sampling site (hatched area).

$p_i * logp_i$, where p_i is the fraction of species i in the sample), and equitability index (J = H'/Hmax) were calculated for the total, the day and the night samples. The indices obtained for day and night samples were compared by Student t-test (Sokal and Rohlf, 1979).

Results and Discussion

A total of 41 species belonging to 20 families were collected (Table I). Labridae with 8 species was the best represented family, followed by Gobiidae (5 species) and Sparidae (4 species). Centracanthidae with 2 species represented 29.3% of the total number of individuals collected, while Scorpaenidae with 3 species represented 24.1% of the total biomass.

The total species richness obtained (Table II) is higher than previously observed in the same area between 2 and 11 m depth (Massuti, 1965). These differences may be due to the selective effectiveness of the sampling gear and differences in species composition between deeper and shallower margins of the seagrass beds (Harmelin-Vivien, 1982). Thus, this parameter is similar to the fish fauna recorded in previous studies of others seagrass beds of similar depth in other areas of the Mediterranean (Bell and Harmelin-Vivien, 1982; Harmelin-Vivien, 1982, 1984). Of a total of 41 captured species, 21 were common to all the reported ichthyofauna for the Mediterranean seagrass meadows and represent more than the 70% of the abundance and the total biomass in all the areas (Table I). The dominance in species number of Labridae and Gobiidae, the presence of Syngnathidae and Gobiesocidae, which despite their little importance in biomass can be considered as exclusive of this community (Harmelin-Vivien, 1984), and the trophic structure, with the absence of herbivore and detritivore species (Bell and Harmelin-Vivien, 1983; Khoury, 1984), are a common feature of the deep Mediterranean seagrass meadows.

However, besides these general trends there were differences in some ecological parameters. Abundance, biomass and species richness found (Table II) were lower than those observed by Harmelin-Vivien (1982) in Port-Cros and by Bell and Harmelin-Vivien (1982) in Marseille, but similar to those recorded by Harmelin-Vivien (1984) in Corsica. The

Table I. - Specific composition, abundance (N°: number of specimens/1000 m^2), biomass (W: g/1000 m^2/+- standard error) and total length range for each species in day and night samples. Species with (*) are common to all seagrass beds of similar depth in the Western Mediterranean.

Families	Species	Day samples			Night samples		
		N°	W (g)	Total length range (mm)	N°	W (g)	Total length range (mm)
Synodontidae	*Synodus saurus*	0.2 ± 0.17	6.2 ± 6.18	165	0.0 ± 0.00	0.0 ± 0.00	-
Syngnathidae	*Syngnathus acus* *	0.7 ± 0.25	4.5 ± 1.70	205 - 275	1.9 ± 0.69	9.2 ± 3.45	60 - 260
	Syngnathus typhle *	0.9 ± 0.16	5.6 ± 1.04	180 - 270	0.6 ± 0.21	4.1 ± 1.85	205 - 250
	Hippocampus hippocampus	0.0 ± 0.00	0.0 ± 0.00	-	0.1 ± 0.08	0.7 ± 0.69	-
Zeidae	*Zeus faber*	0.1 ± 0.08	3.2 ± 3.18	140	0.0 ± 0.00	0.0 ± 0.00	-
Serranidae	*Serranus scriba*	13.7 ± 1.09	180.8 ± 62.47	50 - 185	8.1 ± 1.03	155.1 ± 70.02	50 - 165
	Serranus cabrilla *	0.2 ± 0.23	2.6 ± 2.63	85 - 110	0.6 ± 0.02	12.2 ± 5.52	90 - 120
	Serranus hepatus	0.6 ± 0.43	2.6 ± 2.07	50 - 75	0.0 ± 0.00	0.0 ± 0.00	-
Mullidae	*Mullus surmuletus* *	0.0 ± 0.00	0.0 ± 0.00	-	0.2 ± 0.09	7.2 ± 4.14	100 - 150
Sparidae	*Diplodus annularis* *	24.9 ± 2.97	185.2 ± 42.56	45 - 135	16.7 ± 3.25	112.7 ± 47.81	45 - 145
	Diplodus vulgaris	0.1 ± 0.08	15.5 ± 15.51	230	0.1 ± 0.08	2.4 ± 2.41	100
	Diplodus sargus	0.0 ± 0.00	0.0 ± 0.00	-	0.2 ± 0.09	93.4 ± 60.13	280
	Boops boops	0.0 ± 0.00	0.0 ± 0.00	-	1.9 ± 0.99	11.9 ± 5.46	50 - 130
Centracanthidae	*Spicara smaris* *	0.2 ± 0.20	1.7 ± 1.72	85 - 100	42.8 ± 14.31	490.3 ± 45.01	75 - 120
	Spicara maena *	1.1 ± 0.86	26.0 ± 20.56	60 - 215	17.5 ± 4.59	120.6 ± 61.96	50 - 185
Pomacentridae	*Chromis chromis* *	0.4 ± 0.38	1.2 ± 1.16	50	1.5 ± 0.79	10.6 ± 5.03	50 - 85
Labridae	*Coris julis* *	5.2 ± 2.28	36.2 ± 14.96	60 - 130	2.2 ± 0.66	22.3 ± 10.50	50 - 125
	Symphodus mediterraneus *	5.1 ± 0.90	29.0 ± 4.76	50 - 110	6.0 ± 1.71	42.3 ± 6.05	50 - 125
	Symphodus cinereus *	4.9 ± 1.71	21.3 ± 7.39	50 - 95	1.9 ± 0.46	10.0 ± 4.25	55 - 85
	Symphodus ocellatus *	6.8 ± 1.95	17.7 ± 4.50	45 - 85	8.5 ± 2.41	29.9 ± 14.91	40 - 85
	Symphodus rostratus *	7.5 ± 1.86	35.6 ± 9.25	55 - 100	11.3 ± 1.63	66.9 ± 14.56	55 - 110
	Symphodus tinca *	1.0 ± 0.19	26.3 ± 8.29	115 - 165	0.7 ± 0.42	50.4 ± 37.14	95 - 215
	Symphodus doderleini *	0.8 ± 0.28	4.2 ± 1.53	70 - 90	1.3 ± 0.28	6.9 ± 1.41	60 - 80
	Symphodus melanocercus *	0.0 ± 0.00	0.0 ± 0.00	-	0.1 ± 0.08	0.3 ± 0.30	65
Trachinidae	*Trachinus draco*	0.5 ± 0.53	33.5 ± 33.52	120 - 265	0.2 ± 0.16	10.3 ± 7.41	140 - 170
Uranoscopidae	*Uranoscopus scaber*	0.0 ± 0.00	0.0 ± 0.00	-	0.1 ± 0.08	4.2 ± 4.21	120
Gobiidae	*Gobius cruentatus* *	3.7 ± 1.09	50.3 ± 3.43	70 - 140	4.0 ± 0.75	61.1 ± 20.57	75 - 140
	Gobius niger	0.3 ± 0.30	6.9 ± 6.85	128 - 137	0.1 ± 0.08	1.8 ± 1.85	146
	Gobius sp.	1.3 ± 0.14	3.2 ± 1.13	45 - 72	2.6 ± 0.47	11.5 ± 4.18	45 - 75
	Deltentosteus quadrimaculatus	0.5 ± 0.54	8.9 ± 6.47	50 - 72	0.4 ± 0.23	2.1 ± 1.25	58 - 71
	Pomatochistus sp.	2.8 ± 2.82	3.0 ± 3.00	25 - 43	0.0 ± 0.00	0.0 ± 0.00	-
Bleniidae	*Blennius incognitus*	0.1 ± 0.08	0.2 ± 0.21	69	0.0 ± 0.00	0.0 ± 0.00	-
Atherinidae	*Atherina hepsetus*	0.0 ± 0.00	0.0 ± 0.00	-	0.6 ± 0.60	2.5 ± 2.47	75 - 85
Scorpaenidae	*Scorpaena notata* *	1.2 ± 0.44	40.5 ± 16.33	80 - 160	1.6 ± 0.18	62.6 ± 14.67	70 - 155
	Scorpaena porcus *	4.4 ± 1.45	232.6 ± 75.58	85 - 185	4.6 ± 1.34	189.5 ± 56.05	70 - 160
	Scorpaena scrofa *	0.5 ± 0.31	64.4 ± 32.44	145 - 210	0.4 ± 0.15	58.8 ± 21.43	170 - 200
Triglidae	*Trigloporus lastoviza*	0.2 ± 0.17	6.6 ± 6.57	150	0.0 ± 0.00	0.0 ± 0.00	-
Bothidae	*Bothus podas* *	0.2 ± 0.17	1.9 ± 1.90	95	0.1 ± 0.08	3.8 ± 3.82	125
Soleidae	*Nonochirus hispidus*	0.4 ± 0.35	2.6 ± 2.61	50 - 60	0.1 ± 0.08	0.4 ± 0.43	50
Scophthalmidae	*Lepidorhombus sp*	0.0 ± 0.00	0.0 ± 0.00	-	0.2 ± 0.16	0.1 ± 0.08	40
Gobiesocidae	*Diplecogaster bimaculata*	0.1 ± 0.10	0.1 ± 0.10	32	0.3 ± 0.30	0.3 ± 0.30	32 - 30

Table II. - Species richness, mean species richness, mean number of specimens and biomass (g) by 1000 m^2, diversity index (H') and equitability index (J), obtained in day and night samples, and the whole sampling.

	Day	Night	Day + night
Species richness	33	36	41
Mean species richness	20 ± 1.06	24.3 ± 2.38	22.1 ± 1.61
Diversity (H')	3.373 ± 0.11	3.429 ± 0.15	3.400 ± 0.04
Equitativity (J)	0.782	0.751	0.767
Abundance (fish/1000m^2)	90.47 ± 10.07	139.2 ± 27.09	114.83 ± 16.24
Biomass (g/1000m^2)	1060.11 ± 172.46	1668.31 ± 416.44	1364.21 ± 238.21

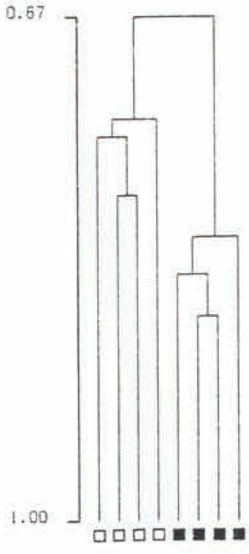

Fig. 2. - Dendrogram based on cluster analysis of samples applied to species abundance data. The mesure of similarity is PS and the clustering algorithms is UPGMA. Open symbols correspond to day samples and filled symbols to night samples.

oligotrophic character of Palma Bay (Fernández de Puelles and Jansá, 1992) could be one of the factors that may explain the lower density of diurnal planktivorous such as *Spicara smaris*, *S. maena*, *Boops boops* and *Chromis chromis*. Moreover, the existence of patches without vegetation in the study area (Rey and Diaz del Rio, 1989), reflected by the presence of characteristic species of sandy bottoms such as *Trachinus draco*, *Uranoscopus scaber*, *Trigloporus lastoviza*, *Synodus saurus* and *Bothus podas*, in our captures, affects the density and the biomass obtained. The composition, diversity and abundance of fish assemblages depend, to some extent, on the physical complexity and size of the seagrass, and on the proximity of other habitats (Bell and Pollard, 1989). According to these authors, seagrass beds are generally better habitats for fish than bare substrata, such as sandy bottoms.

The classification based on relative abundance of species revealed differences between day and night samples (Fig. 2) due to the abundance variation of some species. The most striking feature was the dominance in the night samples of *Spicara smaris* and *S. maena*, which showed a significant difference in abundance and biomass (Student-t, $p < 0.05$). Other species more abundant in night samples were *B. boops*, *C. chromis*, *Atherina hepsetus*, *Syngnathus acus* and *Symphodus rostratus*, while *Coris julis*, *Symphodus cinereus*, *Diplodus annularis* and *Serranus scriba* were more abundant in day samples. The ecological parameters (Table II) were higher in the night samples. Nevertheless, by comparing all the indices for day and night samples, no stastistical significant differences were indicated due to the large variance within samples. These differences between day and night fish assemblages can arise from changes in the catchability of species. This can be attributed to the species behaviour and to its higher vulnerability by night, because the reaction distance of fish is less at low light intensities. These differences have been observed in tropical and temperate seagrass beds (Bell and Pollard, 1989 and references cited there in).

In studies conducted in the Mediterranean, the migration of nocturnally active predators such as Congridae, Gadidae, Ophidiidae and Scorpaenidae to seagrass beds from nearby rocky areas to prey on large crustaceans and small fish (Bell and Harmelin-Vivien,1983), clearly separate day and night fauna. Nevertheless, these variations have not been observed in our study due to the absence of rocky bottoms close to the study area.

In Palma Bay, the fish community is exploited by a small-scale fishery, using trammel-net and bottom long-line, to capture larger Scorpaenidae, Serranidae and Sparidae. Some target species of this fishery were not captured in our study, possibly as a consequence of the relative ineffectiveness of the method used for sampling highly mobile species. Therefore, community structure, both in number of species as well as in length range, could be completed using other sampling device with different selective properties.

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